

Minnesota Space Grant Consortium  
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## **PROGRAM DESCRIPTION**

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Minnesota Space Grant Consortium is a Designated Consortium funded at a level of \$575,000 for fiscal year 2013.

## **PROGRAM GOALS**

**Outcome 1 – Higher Education:** *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals.*

**Goal 1.1:** Enhance diversity in the STEM workforce by providing research and higher education opportunities to women students and students from underrepresented groups.

**Goal 1.2:** Contribute to the STEM workforce by providing research and higher education opportunities to high-performing undergraduate and graduate students attending MnSGC institutions.

**Goal 1.3:** Enhance diversity in the STEM workforce by providing scholarship and fellowship support to women students and students from underrepresented groups.

**Goal 1.4:** Contribute to the STEM workforce by providing scholarship and fellowship support to high-performing undergraduate and graduate students attending MnSGC institutions, including support for students to participate in NASA Center internships.

**Goal 1.5:** Contribute to the STEM workforce by enhancing higher education opportunities for high-performing undergraduate and graduate students attending MnSGC institutions through aerospace design projects and student satellite projects.

**Goal 1.6:** Contribute to the STEM workforce by promoting higher education course development in areas of interest to NASA at MnSGC institutions.

**Goal 1.7:** Enhance diversity in the STEM workforce by promoting research and/or higher education programming at tribal college affiliates of the MnSGC.

**Outcome 2 – Elementary and Secondary Education:** *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty.*

**Goal 2.1:** Enhance the teaching of STEM topics, especially in schools with high underrepresented populations, by supporting precollege teachers through a variety of aerospace-related professional-development opportunities.

**Outcome 3 – Informal Education:** *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA’s mission.*

**Goal 3.1:** Promote familiarity with, and interest in, aerospace and space-related STEM fields and career opportunities by offering a variety of informal education activities around the state.

### PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, & 3)

- Outcome 1: Our engagement of students using high-power rocketry continues to expand. This year we began hosting and co-organizing the Midwest Regional Rocketry Competition, a project of the Wisconsin Space Grant. We anticipate becoming even more central to this competition next year and hope to open it up to teams from states outside the Great (Lakes) Midwest Space Grant Region.
- Outcome 1: We have developed several Arduino-based sensor packs for use in high-altitude balloon payloads and for instrumentation on high-power rockets. These sensor packs and lessons accompanying them have also proved useful as an introduction to microcontrollers and programming for hands-on build teams and in workshops for higher education faculty and students.
- Outcome 2: We have become involved in more public “Expos” than in the past, many aimed at promoting STEM careers to middle school students. In the spring of 2014 alone we exhibited at the “STEM Summit” at St. Cloud State University, the “STEM Expo” for the Minneapolis public school district, the “CSE (College of Science and Engineering) Expo” at the U of MN, and the “Go Boldly Expo” organized by AirSpace Minnesota.

### PROGRAM ACCOMPLISHMENTS

**Outcome 1:** *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA’s strategic goals: (Employ and Educate)*

**Goal 1.1:** Enhance diversity in the STEM workforce by providing research and higher education opportunities to women students and students from underrepresented groups.

**Objective 1.1.A:** Involve underrepresented groups in out-of-class higher education programs to at least a minimum percentage equal to Minnesota demographics for enrollment in higher education (Native American 1.3%, African American 8.9%, and Hispanic 2.3%, for a total of 12.5%) and 50% for women students annually.

**Results:** Partially achieved. Of 38 total out-of-class higher education participants, 8 were women (21%) and 10 were from underrepresented groups (26%). This

indicates that we need to put renewed emphasis on recruiting and engaging especially women students in these out-of-class opportunities.

**Objective 1.1.B:** Involve underrepresented groups in research programs to at least a minimum percentage equal to Minnesota demographics for enrollment in higher education (12.5% – see Objective 1.1.A above) and award 50% of the research stipends to women. This year we plan to fund a minimum of 4 students from underrepresented groups and 15 women students to participate in research annually.

**Results:** Nearly achieved. Of 36 total research stipends awarded, 17 were given to women (47%) and 3 were given to students from underrepresented groups (8%). This year we did fairly well engaging women research participants but we need to work harder, especially to recruit underrepresented students to our undergraduate and graduate research activities.

**Goal 1.2:** Contribute to the STEM workforce by providing research and higher education opportunities to high-performing undergraduate and graduate students attending MnSGC institutions.

**Objective 1.2.A:** Offer high-quality research experiences for at least 38 undergraduate students across the MnSGC annually that motivate students to work in areas of direct interest to NASA and NASA contractors or to pursue graduate studies in aerospace science and engineering.

**Results:** Nearly achieved. In all 36 undergraduate students received research stipends in 2013-2014. An additional 3 graduate students did research at the lead institution but were funded through fellowship/scholarship awards instead of with programmatic research stipends. The reduction in the number of research stipends is directly tied to recent reductions in our budget.

**Objective 1.2.B:** Fund graduate-level research in aeronautics and space physics in areas in which the Principal Investigators have strong, formal relationships with NASA Centers by funding at least 2 Ph.D. students, 1 in Aerospace Engineering and 1 in Space Physics annually, as well as at least 4 additional graduate students in aerospace science, engineering, and/or related fields through the fellowship budget or directly.

**Results:** Not achieved. At the lead institution 2 Ph.D. students from the School of Physics and Astronomy (SPA) plus 1 Masters student in Aerospace Engineering and Mechanics (AEM) were partially supported with fellowships to do research. No additional graduate student research was supported this year, in part due to recent reductions in our budget. All students worked on research under advisers with strong formal relations with NASA Centers.

**Objective 1.2.C:** Provide seed funding to assist investigators with little or no previous contact with NASA develop collaborative programs with Centers and Directorates. Expect at least 1 young investigator will be partially funded annually to seek collaborative contacts with appropriate NASA Centers.

**Results:** Achieved. Continued support of young investigator Lucy Dunne at the U of MN – Twin Cities to expand her collaboration with JSC on spacesuit design that is impacting both her research and a class she teaches on wearable technology and now involves two other Space Grants. We continue to encourage young faculty across the MnSGC to consider focusing their research on NASA priorities

and to make contacts, both at NASA Centers and among more-senior faculty in the state who already have NASA connections.

**Goal 1.3:** Enhance diversity in the STEM workforce by providing scholarship and fellowship support to women students and students from underrepresented groups.

**Objective 1.3.A:** Provide scholarships (and fellowships) for underrepresented students to at least a minimum percentage equal to the most recent Minnesota demographics for enrollment in higher education (12.5% – see Objective 1.1.A above) and make 50% of scholarship/fellowship awards to women students annually.

**Results:** Achieved. Of 62 total fellowships and scholarships that were awarded, 32 were given to women (52%) and 28 were given to students from underrepresented groups (45%).

**Goal 1.4:** Contribute to the STEM workforce by providing scholarship and fellowship support to high-performing undergraduate and graduate students attending MnSGC institutions, including support for students to participate in NASA Center internships.

**Objective 1.4.A:** Offer opportunities for all qualified students at our affiliates to participate in the MnSGC Fellowship and Scholarship Program annually by providing (a) at least 30 institution-specific undergraduate scholarships, (b) at least 4 Consortium-wide undergraduate scholarships, and (c) at least 2 graduate student fellowships (partial support).

**Results:** Achieved, except for one program which has been discontinued. Of 62 total fellowship/scholarship awards, 39 were made to undergraduates by MnSGC affiliates (i.e. not by the lead institution and not to students attending institutions outside the consortium) and 14 went to undergraduates at the lead institution. We elected to discontinue our Consortium-wide scholarship program since all affiliates now award their own scholarships. As mentioned above, we also partially supported 3 graduate students with fellowships. Another 7 students received “scholarship” awards for summer internships at NASA Centers. A few students received awards in more than one category.

**Objective 1.2.2.B:** Offer scholarship support for at least 6 students to participate in NASA summer internships and other activities at NASA Centers annually. (Note that since final internship selections are made by the Centers, we cannot guarantee that this many Minnesota students will actually receive offers from NASA Centers.)

**Results:** Achieved. A total of 7 Minnesota students were partially-supported by the MnSGC at NASA Center internships during the summer of 2013.

**Goal 1.5:** Contribute to the STEM workforce by enhancing higher education opportunities for high-performing undergraduate and graduate students attending MnSGC institutions through aerospace design projects and student satellite projects.

**Objective 1.5.A:** Support the aerospace design program at the U of MN – Twin Cities by providing at least 5 aerospace design projects sponsored by industry or government annually.

**Results:** Achieved. Five (out of eight) aerospace senior design projects during 2013-2014 were sponsored, in part, by industry or government.

**Historical Objective 1.5.B:** Engage a new industrial partner, ASTER Labs, in the development of instrumentation for at least 1 student-launched flight project.

**Results:** Achieved. An update: The U of MN – Twin Cities is now in their third year developing a HASP ballooning payload to study X-ray communication and navigation and ASTER Labs, a small start-up company, is involved in providing external mentoring for the student team.

**Objective 1.5.C:** Participate in the National Space Grant Student Satellite Program by maintaining at least 3 different types of active student aerospace hardware programs involving students from at least 3 different institutions in the MnSGC annually.

**Results:** Achieved. Aerospace-related student hardware projects in high-altitude ballooning, NASA-scale ballooning (payload-building), high-power rocketry, and RC aircraft programs are going on at a total of 7 institutions in the MnSGC and our workshops have also led to the establishment of high-altitude ballooning programs at 2 non-MnSGC institutions.

**Historical Objective 1.5.D:** Expand student-led high-altitude ballooning and/or suborbital programs to at least 1 additional affiliate in 2010-2011.

**Results:** Achieved. An update: Bemidji State University, working with Central Lakes Community College in Brainerd, plus Augsburg College and St. Catherine University all established high-altitude ballooning programs since this objective was first written.

**Historical Objective 1.5.E:** Support participation in the NASA's USLI (University Student Launch Initiative (high-power rocketry) program) by community college students. Expect at least 1 faculty/student team to attend a USLI workshop and participate in the subsequent rocket competition in 2010-2011.

**Results:** Achieved. An update: USLI was very late in being announced this year so no Minnesota schools elected to get involved, but 4 MnSGC institutions are building rockets for the Midwest Regional Rocketry Spring 2014 Competition and a team from the lead institution also plans to attend the Utah rocketry competition in June 2014.

**Goal 1.6:** Contribute to the STEM workforce by promoting higher education course development in areas of interest to NASA at MnSGC institutions.

**Objective 1.6.A:** Support undergraduate Higher Education activities at MnSGC affiliates by providing support for at least 5 new or ongoing courses or academic programs annually.

**Results:** Achieved. At the lead institution the MnSGC supports freshman seminars on high-power rocketry, high-altitude ballooning, and RC aircraft as well as aerospace senior design projects at both the U of MN – Twin Cities (lead institution) and U of MN – Duluth. Curriculum development took place on another 15 courses around the consortium in physics, geology, environmental studies, introductory engineering, astronomy, earth science, cosmochemistry, and STEM teacher education.

**Historical Objective 1.6.B:** Develop new educational opportunities using radio controlled (RC) model aircraft design/build/fly programs. Expect course develop-

ment will begin for a new freshman seminar in this area at the lead institution in 2010-2011.

**Results:** Achieved. An update: The RC aircraft freshman seminar was successfully offered for a fourth time in the spring of 2014 at the lead institution.

**Goal 1.7:** Enhance diversity in the STEM workforce by promoting research and/or higher education programming at tribal college affiliates of the MnSGC.

**Objective 1.7.A:** Enhance STEM educational opportunities at tribal college affiliates by facilitating at least 1 research or higher education program at both LLTC (a tribal college) and FDLTCC (formerly a tribal college) annually.

**Results:** Achieved. Both LLTC and FDLTCC have on-going high-power rocketry programs and both built rockets for the Spring 2014 First Nations Rocketry Competition sponsored by the WI Space Grant. FDLTCC is also competing in the Spring 2014 Midwest Regional Rocketry Competition – the only institution to be doing both competitions.

**Historical Objective 1.7.B:** Support participation in high-power rocketry by tribal college students. Expect at least 1 high-power rocketry team to be operational at a tribal college (LLTC) starting in 2010-2011.

**Results:** Achieved. An update: LLTC is continues to participate annually in the Tribal College category of the First Nations Rocketry Competition.

**Outcome 2:** *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty: (Educate and Engage)*

**Goal 2.1:** Enhance the teaching of STEM topics, especially in schools with high underrepresented populations, by supporting precollege teachers through a variety of aerospace-related professional-development opportunities.

**Objective 2.1.A:** Improve the formal and informal teaching of science and mathematics at the precollege level by offering at least 2 formal short-duration programs annually in which at least 50% of the participating teachers subsequently use the materials/activities in their own teaching.

**Results:** Achieved. Five short-duration teacher workshops and two long-duration teacher workshops, engaging a total of 101 in-service teachers, were offered this year by the MnSGC. Teacher workshop included an Aerospace Camp by MNDOT, a workshop on the Curiosity rover by Concordia, and two ballooning/Arduino workshops by the U of MN – Twin Cities. Post-workshop participation rate exceeded 50% for each of the workshop offerings.

**Historical Objective 2.1.B:** Offer additional summer short courses and/or workshops annually, especially for middle school educators and/or students at several venues in Minnesota. Expect workshops or short courses specifically for middle school educators and/or middle school students will be delivered or developed at a minimum of 3 locations in 2010-2011.

**Results:** Achieved. An update: Our teacher activities are not usually limited to middle school, but most participants teach at that level. For example, in the summer of 2013 Bemidji State University offered a Geosciences workshop and most of the 10 attendees were middle/high school teachers and all of them reported using the materials in their own teaching. The lead institution worked on a ballooning initiative with gifted classes at 2 middle schools in the Twin Cities

area and another affiliate, St. Catherine University, ran a ballooning program for local 4-H educators and students, mostly middle-school age.

**Objective 2.1.C:** Promote the teaching of mathematics, science, and pre-engineering by working with teachers from at least 3 schools annually that serve primarily underrepresented students, to familiarize them with aerospace curricula.

**Results:** Achieved. Three MnSGC affiliates work regularly with teachers and students from seven pre-college schools on high-altitude ballooning and other aerospace topics. Three of these schools serve predominantly underrepresented students.

**Outcome 3:** *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission: (Engage and Inspire)*

**Goal 3.1:** Promote familiarity with, and interest in, aerospace and space-related STEM fields and career opportunities by offering a variety of informal education activities around the state.

**Objective 3.1.A:** Promote aerospace and space related sciences through informal education activities around the state annually. Survey a representative sample of participants and expect that at least 75% of respondents agree that the informal education activities were valuable to them (or to their groups, if they are a group leader).

**Results:** Achieved. Informal education activities were offered by ten different institutions in the MnSGC this past year, with MNDOT and the U of MN – Twin Cities both offering multiple activities. Not all activities were done in contexts where it was practical to formally survey attendees but the affiliates that were able to do so all reported more than 75% of the participants agreed the activities were valuable to them.

## PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Student Data and Longitudinal Tracking:**

Note: These values pertain only to students supported in FY13 who have reached the “significantly-supported” level, some through multiple, cumulative awards.

Total awards = 43; Fellowship/Scholarship = 17, Higher Education & Research Infrastructure = 26. A total of 1 Fellowship/Scholarship award, 1 Research Infrastructure award, and 1 Higher Education award were made to students from underrepresented groups. A total of 9 Fellowship/ Scholarship awards, 7 Research Infrastructure awards, and 1 Higher Education award were made to women students.

During the FY13 program year 6 students started pursuing advanced degrees in STEM disciplines, 2 accepted STEM positions with NASA contractors, 1 accepted a STEM position in industry, 1 went into the Air Force, and 4 reported having graduated and seeking STEM positions. The remaining students in our longitudinal tracking pool have not yet received the degree they were pursuing when they received their most recent Space Grant award.

- **Minority-Serving Institution Collaborations:**

We currently have one minority-serving institution, Leech Lake Tribal College (LLTC). They are an active participant and have been using MnSGC funding to provide scholarships to their students and to fund a high-power rocketry team to compete in the First Nations Tribal Rocketry competition annually since the spring of 2012. Their rocket team has also done STEM outreach to Boys and Girls Clubs in their community.

- **NASA Education Priorities:**

- Authentic, hands-on student experiences in science and engineering disciplines – the incorporation of active participation by students in hands-on learning or practice with experiences rooted in NASA-related, STEM-focused questions and issues; the incorporation of real-life problem-solving and needs as the context for activities.

**Results:** Aerospace hardware student-led teams and class projects bring hands-on NASA experiences to students at 9 different Minnesota colleges, 7 at MnSGC schools and 2 at a non-MnSGC schools collaborating with MnSGC institutions.

- Diversity of institutions, faculty, and student participants (gender, under-represented, underserved).

**Results:** The 14 MnSGC affiliates range from a small tribal college to one of the nation's largest Ph.D.-granting public universities. One affiliate is a State Agency and one is a women-only higher education institution. Affiliates are located in all geographical areas of Minnesota. Five affiliate directors are female. This year we exceeded our participation goals for underrepresented students in Scholarships/Fellowships and Higher Education (out-of-class activities), but not Research. We met our participation goals for women students in Scholarships/Fellowships and Research, but not Higher Education (out-of-class activities). We continue to work with our affiliates to pursue ways to increase diversity across all MnSGC activities.

- Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise. Capabilities for teachers to provide authentic, hands-on middle school student experiences in science and engineering disciplines (see above).

**Results:** The bulk of the ~100 teaches attending MnSGC teacher workshops this year were middle school teachers. Four Twin Cities middle schools from three different school districts are actively working on ways to provide their own high-altitude ballooning flights, advised by the MnSGC, to get beyond the limited flight opportunities we can offer them.

- Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers.

**Results:** The MnSGC does not currently offer any programming in this NASA Education Priority area.

- Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges.



**Results:** High-power rocketry programs continue at our two community college/tribal college affiliates, LLTC and FDLTCC. Bemidji State University is working with Central Lakes Community College in Brainerd which is not a MnSGC affiliate, on a joint high-altitude ballooning program. Inver Hill Community College, also not a MnSGC affiliate, sent a faculty member and a student to a MnSGC ballooning workshop and is now considering starting up a high-altitude balloon program.

- Aeronautics research – research in traditional aeronautics disciplines; research in areas that are appropriate to NASA's unique capabilities; directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen).

**Results:** An undergraduate student developed a free-to-roll wind tunnel sting to be used to study the loss of roll stability at high angles attack for general aviation aircraft. Loss of roll stability is a precursor to stall/spin which is a significant cause of fatal accidents in general aviation aircraft. This was sponsored by Cirrus Aircraft with cooperation with personnel at NASA Langley Research Center.

- Environmental Science and Global Climate Change – research and activities to better understand Earth's environments.

**Results:** MnSGC-sponsored course development and course offerings in Environmental Science and Global Climate Change occurred at two institutions in 2013-2014.

- Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities.

**Results:** Continued support of spacesuit design work at lead institution by Professor Lucy Dunne (see Objective 1.2.C above) and support of spectroscopy research by early-career physics professor, Nate Linquist, at Bethel University.

## IMPROVEMENTS MADE IN THE PAST YEAR

- Streamlining data collection for APD reporting and OEPM reporting.
- Deepening our relationship with Century (Community) College, not a MnSGC affiliate, started with ULSI rocketry collaboration, then working on a joint proposal for the Innovative Pilot in STEM Education, and now exploring how they might be involved in our Community Colleges & Technical Schools Solicitation proposal.
- Serving on Advisory Boards for two new aerospace informal education providers in Minnesota, AirSpace Minnesota and MNAWA (the Minnesota Association of Women in Aviation and their “Learning Jet” Boeing 727 educational-rehab project).
- Expanding our educational reach in the state by offering high-altitude ballooning (and Arduino) workshops to schools outside of our consortium, including Inver Hills Community College, Gustavus Adolphus College, and the Bloomington Public School District.

## PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

- Augsburg College: M.S.-granting, private; Undergraduate Research, Higher Education, Informal Education
- Bemidji State University (BSU): M.S.-granting, public; Undergraduate Research, Higher Education, Pre-College
- Bethel University: M.S.-granting, private; Undergraduate Research, Higher Education
- Carleton College: 4-year, private; Undergraduate Research, Informal Education
- Concordia College: 4-year, private; Undergraduate Research, Higher Education, Pre-College, Informal Education
- Fond du Lac Tribal and Community College (FDLTCC): 2-year, public community college (combined with a 2-year tribal community college); Higher Education, Pre-College
- Leech Lake Tribal College (LLTC): 2-year, tribal community college; Higher Education
- Macalester College: 4-year, private; Undergraduate Research
- Minnesota Department of Transportation (MNDOT): State agency; Pre-College, Informal Education
- Southwest Minnesota State University (SMSU): 4-year, public; Pre-College, Informal Education
- St. Catherine University (St. Kates): M.S.-granting, private (main campus is women-only); Undergraduate Research, Higher Education, Informal Education
- University of Minnesota – Duluth (UMD): M.S.-granting, public; Undergraduate Research, Higher Education
- University of Minnesota – Twin Cities (UMTC): Ph.D.-granting, public; Consortium Administration, Undergraduate and Graduate Research, Higher Education, Pre-College, Informal Education
- University of St. Thomas (UST): M.S.-granting, private; Undergraduate Research, Informal Education

**The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD) and the Office of Education Performance Measurement System (OEPM) report. The former is primarily narrative and the latter data intensive. Because the reporting timeline cycles are different, data in the two reports may not necessarily agree at the time of report submission. OEPM data are used for official reporting.**